

# CHARGER ENTERPRISES,

#### INC.

P.O. Box 4646 Seminole Florida 33775-4646 14815 Seminole Trail, Seminole Florida 33776 Phone (727) 593-8600 Fax (727) 593-5520

# PERVIOUS CONCRETE SPECIFICATION Updated July 26, 2006

© Charger Enterprises, Inc. All rights reserved.

#### **FOREWORD**

The use of Pervious Concrete Pavement (Also known as "no fines" concrete, and porous pavement) has continued to gain acceptance as an ecologically friendly alternative to asphalt, impervious concrete and porous paving blocks. It is used to treat, control and to partially contain storm water runoff, and it will spur on continued growth for Pervious Concrete for decades to come. Though its largest demand is for parking and paving areas, it can also be used as a sound absorption pavement and as an underlayment to relieve hydrostatic pressure under asphalt or impervious concrete paving. It may also be used for light aircraft taxiways or tarmacs to make use of its ability to prevent of puddling and to enhance the grip of rubber tires on pavements. It is also being used as a base for playgrounds where it is covered with shredded rubber tire mulch or other pervious, soft, materials.

It can reduce the need for retention and detention ponds, especially when used in conjunction with a sub-base designed with void containing soils and crushed aggregates. A ten inch sub base of crushed limestone or recycled concrete can store about three inches of rain water until it permeates through the ground below. This sub-base in combination with soils of variable permeability above the seasonal high water table will determine the water storage capacity

of the total drainage-absorption system. Generally, soils that will support septic systems will also support Pervious Concrete.

Engineers and officials who are reluctant to work with Pervious Concrete, have usually developed that reluctance due to, 1. Failures due to installation by untrained installers, 2. Lack of suffficient appreciation or education about the positive environmental impact that Pervious Concrete is making internationally, or, 3. Inertia. (It took a while for computers to be appreciated and not fought!) Pervious concrete is a proven green product that is reducing the environmental impact of outdoor pavements and helping struggling aquifers while reducing storm water pollution!

Traditional Portland cement pavement testing procedures that are based upon strength, air content and slump control are not applicable to this type of pavement material. Whatever test procedures are to be used, or not used, including, but not limited to those specified herein, must be agreed to by the owner, engineer/architect, material suppliers and anyone else with a vested interest, before work commences. Since traditional application and testing procedures for concrete paving are not applicable to this type of material, these specifications are based upon Charger Enterprises more than 20 years experience with installing.

Slab thickness is best tested by verification of the depth of forms, and by random thickness measurements taken during the placement process. If core samples are to be taken after the pour, the testing organization will be responsible to repair the core cavities with Pervious Concrete under Charger supervision.

Pervious Concrete. As continued testing of this product yields additional test methods that are relevant, cost effective and reproducible in the field, these specifications will be modified. The entire layered pervious concrete system is critically dependant upon the quality of the pervious concrete surface layer. If the mix is designed properly, and then it is placed expeditiously and correctly, the system will perform exceptionally well in retaining and filtering storm water. However, many contractors familiar with other materials may not be skilled or sufficiently educated to properly apply this product in compliance with its unique application requirements. Furthermore they may not have the correct tools and equipment required by this material to work within the placement time constraints and its finishing and curing specifications. Steel forms and power screeds are a necessity in Pervious Concrete Placement. Proper steel rollers must be used immediately behind screeding.

The system is also critically dependent on what is beneath it. Important factors include the preparation of the sub-grade, the percolation ability of the base soils and the fluctuating level of the water table below. Also important is whether the water below is constricted or flowing. In almost all cases the flow of storm water through the pervious concrete will closely equal the ability of the system below to receive it.

#### 100. GENERAL PROVISIONS.

#### 101. Scope of Work:

The work to be performed under this contract will be defined by appropriate referenced plans or drawings. The testing and preparation of the sub-base may be delegated to the general contractor or owner by mutual agreement. Specifications for base and subsoil preparation shall be observed with certified strict compliance.

The Pervious Concrete Contractor does not assume any responsibility for site work impacting his services unles designiated by contractural agreement prior to commencement of site work.

Included in the performance of the work is the furnishing of all labor, equipment and materials. The contractor shall also provide instruments required for leveling and placing forms, special and standard equipment required for placing and finishing materials, and also be responsible for the tight scheduling of the arrival of material at the appropriate time for placement. Extreme weather conditions will be a factor in scheduling and placement.

Material suppliers shall certify that each ready-mixed batch shall be in compliance with mix specifications. Damages or failures caused by deviations from mix specifications shall be the responsibility of the concrete mixture supplier.

#### 102. Contractor Qualifications:

Pervious Concrete Contractors should be ACI Flatwork Certified Finishers, and must be able to demonstrate at least three years of competent work with this material. The contractor must be able to submit a list of at least three jobs completed to the previous job's owners', engineers' or architects' satisfaction during that time. Any applicable test results from previous jobs shall be furnished to the Owner/Engineer/Architect if requested.

102.1. If either the Pervious Placing Contractor or the Pervious Concrete Producer have no prior experience with Portland Cement, Pervious Concrete Pavement; the Contractor shall retain an experienced Consultant to supervise production, base preparation, placement and finishing. Expense of the consultant shall be the responsibility of the Contractor.

#### 103. Concrete Mix Design:

If requested, the Pervious Contractor shall furnish a proposed mix design with proportions of materials

to Owner, Owner's Agent or Contracted Engineer prior to commencement of work.

Since Pervious Concrete is much different in performance characteristics, the rodded unit weight sampling is inappropriate and meaningless. However, if testing is required, core samples can be tested after 28 days for compressive strength according to ASTM C-39 with a minimum of three samples being tested, from a 1,000 square foot slab and one additional sample taken for each additional 2,000 Square feet. Samples should be randomly taken from the slab, and core cavities must be refilled with pervious concrete. Samples can also be measured for thickness, density and compaction. 104. Testing Agency Procedures:

Testing procedures shall be established as an integral part of this specification. The level of testing and methods to be used shall be agreed to by all involved parties. Charger Enterprises and/or its material suppliers reserve the right to exclude any test procedures which do not properly address the unique characteristics of pervious concrete. If a testing laboratory is to be employed, it shall be the responsibility of the owner to select and pay for such testing. Only qualified testing laboratories employing experienced technicians or engineers who are thoroughly familiar with Pervious Concrete installations shall be used. Testing agencies shall have at least three years experience with Pervious Concrete work.

#### 104.1 Test Panels:

If so required by the contract, the Pervious Contractor may be required to prepare test panels as specified by the architect, engineer or owner. Cost of creating and removing such panels shall be covered by a line item in the contract and contract proposal. If 12' x 12' or some other size, sample panels are required for evaluation, they will be provided, if so directed by specification. Test panels shall be of the same thickness as the poured slab, with the same sub-base, and shall be identified by date and batch or truck load. When practical, sample panels shall be of a size that will allow them to be integrated into the

final pavement project, if accepted.

- ✓ Requirements for acceptance of panels: The thickness of the slab shall measure no less than ½" of the designed thickness.
- ✓ Panels shall be devoid of any skin of Portland Cement at the bottom or top of the slab. Such skin can prevent the passage of water through the slab at its designed percolation rate.
- ✓ Void containment of the slab shall be between 15% minimum and 22% maximum.
- ✓ Unit weight shall be within  $\pm$  5% of the mix design.
- ✓ A minimum compressive strength according to ASTM C-39, of 300 psi ± 10% shall be required.
- ✓ Samples shall demonstrate a percolation rate of 90 or more of the percolation of the Pervious Concrete Base.
- ✓ In the event that owner does not want samples taken from the final pavement, test samples, 4ft. X 4ft. placed adjacent to the final pavement may be created during the pours. Base, thickness and batch shall be identical to the final pavement.

Removal of noncompliant panels shall be the responsibility of the Pervious Contractor as well as removal to an approved disposal site.

# **104.2 Previous Pervious Projects:**

Demonstration of pervious installation skills may also be provided through the available inspection, and evidence of satisfactory performance, of previously completed projects using Pervious Concrete. References by Owners, Engineers or Architects, related to previous successful projects may be provided as appropriate or as requested. If the contractor can show no examples of previously installed work please see **102.1** above.

#### 200. MATERIALS:

#### 201. General:

Locally available materials having a record of consistency and satisfactory performance shall be used. To date, in Florida, limestone has proven to be the aggregate of choice. River gravel and granite lack the characteristics of limestone, and reduce bond strength with cement paste. Any deviation shall be by mutual agreement. Charger Enterprises has evolved, with the cooperation of its material suppliers mixtures that provide the optimum of strength, workability and price. These formulas can be submitted to the owner's engineer if so requested, but such knowledge shall be considered privileged and proprietary, and distribution to unapproved parties shall be prohibited.

#### 202. Ingredients:

Components of mixture shall consist of Portland cement, limestone, or other locally available, proven satisfactory aggregate, admixtures and stabilizers as appropriate, and water which complies with local concrete paving mix specifications.

#### **202.1. Cement:**

Cement shall be Portland Cement Type I or II conforming to ASTM C-150 or Portland Cement IP or IS conforming to ASTM C-595.

# 202.2. Fly ash and Ground Iron Blast Furnace Slag:

Flyash conforming to ASTM-C618 may be used in amounts not to exceed 20 percent of total cementitious material. Ground Iron Blast Furnace Slag conforming to ASTM C989 may be used in amounts not to exceed 50 percent by weight of total cementitious material.

#### 202.3. Aggregate:

Though No. 8 coarse aggregate as specified by FDOT

(3/8 to No. 16) per ASTM C 33 or No. 89 Coarse Aggregate (3/8 to No. 50) per ASTM D 448 has been widely used, Charger has had better percobility results using Vulcan rock ½". For mix design incorporating fine aggregate it shall conform to FDOT Specification #902. Other limestone aggregates up to 1" may be used upon approval of Charger Enterprises, the Ready Mix Concrete vendor, and any involved Engineer, Architect or Owner's Representative. For best results aggregate shall be triple washed to remove fines thus enhancing percolation.

#### **202.4** Air Entraining Agents:

Air entraining agents shall comply with ASTM C-260.

#### 202.5 Admixtures:

Type A Water Reducing Admixtures shall comply with ASTM C-494.

Type B Retardation Admixtures shall comply with ASTM C-494.

Type D Water Reducing/Retarding Admixtures shall comply with ASTM C-494.

Hydration stabilizers which are often recommended and sometimes required shall also meet the requirements of Type B Retardation Admixtures or Type D Water Reducing/Retarding Admixtures.

Additional bonding agents may be included in mix based upon proven advantages and by mutual acceptance of all parties, who have a vested interest involved. They may include, but are not limited to polymer based, or silica based ingredients and must not interfere with necessary hydration processes. These will be considered as admixtures.

#### 202.6 Water:

Water shall be potable or shall comply with FDOT Standard Specifications, Section 923.

#### 300. PROPORTIONS.

#### **301. Cement Content:**

For pavement being used by vehicular traffic, the total cementitious material shall not be less than 600 lbs. per cubic yard of mix.

#### **301.1 Lower Cementitious Material Content:**

If required, and if material performance can be achieved and verified using a lower cementitious content, minimum cement content may be lowered upon approval of owner's engineer or its agent.

#### 302. Aggregate Content:

The volume of aggregate specified above shall be equal to 27 cu. ft. per cu. yd. when calculated as a function of the unit weight determined in accordance with ASTM C-29 jiggling procedure. The 27 cu.ft. Includes the 15% th 25% Fine aggregate, if used, should not exceed 3 cu. ft. and shall be included in the total aggregate volume. Such fine aggregate will reduce water percolation and retention of the pavement.

(Note! Some specifications have called for 27 cubic feet of aggregate per cubic yard of Pervious concrete.

That does not allow for voids or the volume of Portland Cement, water or admixtures.)

#### 303. Admixtures:

Admixtures may be appropriate for numerous reasons. They shall be used according to manufacturer's directions including storing, mixing, placing and curing.

#### 304. Water.

Water quantity which is an extremely critical component shall be such that the cement paste displays a <u>wet metallic sheen</u> without causing the cement paste to flow from the aggregate. (If mix appearance is dull-dry, insufficient water has been added for hydration to properly occur. The pavement will not develop its designed strength.)

✓ Insufficient water content will also cause inconsistency in the mix and reduce bond strength. This will cause aggregate to separate from the pavement over time.

✓ Too much water content will result in the paste forming membranes which seal the void system primarily at the bottom of the slab. It also may cause a poor surface bond.

# **400. SUBGRADE PREPARATION AND FORM WORK:**

#### 400.1 Preliminary Engineering.

Prior to the specification of Pervious Concrete for any paving application, the Owner through a qualified Engineer and/or the General Contractor shall be responsible for evaluation of existing soils relative to stability, drainage and the identifying of any buried organic material or hazardous waste.

Any problems will then be professionally identified and properly addressed and remedied as appropriate, either under the responsibility of the pervious contractor, the general contractor or any other specialty contractor designated by the owner or engineer involved.

In no case can any organic material such as roots, wood, stumps, sod, etc. be allowed to remain in soil below sub-base. Neither can clay nor organic sludge be tolerated

#### 401. Sub-grade Material:

After any problems with the previously undisturbed soil have been corrected, a sub-base shall be installed of a minimum 6" of a granular or gravely soil that is predominately sandy with no more than a moderate amount of silt or clay. It shall be compacted by a vibratory compactor to a minimum density of 92% of a maximum dry density as established by ASTM D 1157 or AASHTO T 180.

Up to 10" of crushed stone or recycled, crushed concrete may also be used to enhance water storage. A choice of the best available soil shall be made by an engineer if appropriate.

**401.1.** Subgrade moisture. The subgrade shall be in a moist condition (within  $\pm$  3% of the optimum moisture content determined by the modified compaction test ASTM D 1157 or AASHTO T 180).

**402. Sub-grade Permeability:** Prior to the placement of Portland Cement Pervious Pavement, the sub-grade shall be tested for the rate of permeability by the double ring infiltrometer, or such other suitable test that will be agreeable to all parties concerned. Test borings are recommended to determine soil conditions and water table level. A layer of clay discovered less than 5' below the base may restrict the permeability of the Pervious system. Borings may not be required if undisturbed soil under base demonstrates good permeability and stability and has not been disturbed for three years or more. Permeability testing and certification if required will be the responsibility of the Owner or General Contractor.

#### 403. Sub-grade Support:

The sub-grade material shall be placed and compacted in layers of a thickness that can be compacted by a mechanical vibratory roller or compactor to a minimum density of  $94 \pm 2\%$  as determined by ASTM D-1557 or AASHTO-T-180. A minimum Limerick Bearing Ratio (LBR) of  $20 \pm 2$  shall be obtained in the top 6 inches of sub-grade. Sub-grade stabilization shall be performed if, and as, directed by a qualified engineer. Such engineering services shall be performed if needed at the expense and oversight of the Owner or the General Contractor.

If fill material (embankment) is required to bring subgrade to final elevation, it shall be clean and free of deleterious materials. It shall be placed and compacted in maximum layers of 8". Layers shall be

compacted by a mechanical vibratory roller or compactor to a minimum density of 92% of maximum dry density as established by ASTM-D 1557-D or AASHTO-T-180.

#### 404. Sub-grade Moisture:

The sub-grade shall be in a moist condition with no free standing water (within  $\pm$  3% of the optimum moisture content as determined by the modified compaction test ASTM-D-1557 or AASHO-T-180).

#### **405. Forms:**

Forms shall be of, reinforced plastic or steel. If wood is used it should be used sparingly. This is because wood is more likely to swell and warp from moisture, and may move under screed vibration and compaction.

Forms shall be the depth of the pavement, or be elevated with steel pins and supported to provide the desired depth of pavement. (Steel forms have proven to provide the best support for power screed machines and to contain the pressures exerted by compacting rollers.) Appropriate release agents shall be applied to the forms before placing concrete, and to rollers used in compaction.

Forms shall be set to specified elevations, and those elevations shall be rechecked immediately prior to the placement of the pervious cement, aggregate mix. Elevations shall be established and checked by a laser or other suitable device.

#### **500. MIXING, HAULING AND PLACING:**

#### 501. Mix Time:

Truck mixers shall be operated at the speed designated as mixing speed by the manufacturer for 75 to 100 revolutions of the drum.

#### 502. Transportation:

The Portland cement aggregate mixture may be

transported or mixed on site and must be used within one (1) hour of the introduction of mix water, unless otherwise approved by an involved engineer. This time may be increased to 120 minutes when utilizing an approved retarding admixture or the hydration stabilizer specified in Section 205.

#### 503. Discharge:

Each mixer truck driver will provide a certificate guaranteeing mix conformity with specification. Each batch will be inspected by the pervious concrete contractor or his qualified agent, for appearance of concrete uniformity according to Section 304. Water may then be added to obtain the required mix consistency. A minimum of 20 revolutions at the manufacturer's designated mixing speed shall be required following any addition of water to the mix. Discharge shall be a continuous operation and shall be completed as quickly as possible. Concrete shall be deposited as close to its final position as practicable and at a point so that fresh concrete enters and adheres to the mass of previously placed green concrete. The practice of discharging onto sub-grade and pulling or shoveling to final placement is not allowed.

#### 504. Placing And Finishing Equipment:

Unless otherwise approved by the Owner or Engineer in writing, the contractor shall provide mechanical equipment of either slipform or form riding with a following compactive unit that will provide a minimum of 10 psi vertical force. The pervious concrete pavement will be placed to the required cross section and shall not deviate more than  $\pm 3/8$ " in 10' from the profile grade (3/8 inch in 10 feet). If placing equipment does not provide the minimum specified vertical force, a full width roller or other full width compaction device that provides sufficient compactive effort, shall be used immediately following the strike off operation. After mechanical or other approved strike off and compaction operation, no other finishing operation will be allowed. If vibration, internal or surface applied, is used; it shall be shut off immediately when forward

progress is halted for any reason. The Contractor will be restricted to pavement placement widths of a maximum of fifteen (15) feet unless the contractor can demonstrate competence to provide placement greater than the maximum specified, to the satisfaction of the Engineer.

During placement, care should be taken to avoid workers stepping into the mix during placement. Footprints can compress and force cement paste into the voids at the bottom of the slab, forming resistance to the percolation through the slab.

Pervious Concrete does not lend itself to being pumped. However it can be placed using a belt conveyor.

### 505. Curing:

Curing procedures shall begin within twenty (20) minutes after the final placement operations. The pavement surface shall be covered with a minimum six (6) mil thick polyethylene sheet or other approved covering material. Prior to covering a fog or light mist shall be sprayed above the surface when required, due to ambient conditions (temperature, wind and humidity). The cover shall overlap all exposed edges and shall be secured (without using dirt or stone) to prevent dislocation due to winds or adjacent traffic conditions.

#### 505.1 Cure Time:

- 1. Portland Cement Type I, II, or IS 7 days minimum.
- 2. Portland Cement Type I or II with Class F Flyash (as part of the 600 lbs./cy minimum cementitious) or
- 3. Type IP 10 days minimum.

No truck traffic shall be allowed for 10 days following placement. (For passenger cars/light trucks no traffic shall be allowed for 7 days.)

## 506. Jointing:

Though some engineers have recommended the installation of control (contraction) joints at 40 foot intervals, we have learned that the use of these joints may be counter productive causing excessive raveling. Because of the void structure of pervious concrete, we have found control joints to be unnecessary in most cases. When required we have also found that saw cut joints at 40 foot intervals have also proven to accommodate contraction without causing significant stress cracking. Saw cutting should be performed seven (7) days after placement. If it is insisted that control joints be used, it is at the risk of the owner and engineer making the request.

In such case they shall be installed at a depth of 1/4 of the thickness of the pavement. If joints are saw cut, the procedure should begin as soon as the pavement has hardened sufficiently to prevent raveling and uncontrolled cracking (normally after Traverse construction joints shall be curing). installed whenever placing is suspended for a sufficient length of time so that concrete may begin to harden. In order to assure aggregate bond at construction joints, a bonding agent suitable for bonding fresh concrete to existing concrete shall be brushed, rolled or sprayed on the existing pavement surface edge. Isolation (expansion) joints will not be used except when the pavement is abutting slabs or other adjoining structures.

# 600. TESTING, INSPECTION AND ACCEPTANCE:

# 601. Laboratory And/Or Field Testing:

All laboratory test procedures shall be established by the mutual consent of Charger Enterprises, the Owner, General Contractor and any engineer or architect representing the concerns of the Owner, or any other entity having a financial interest in the project.

### 601.1. Laboratory Testing.

The Owner or General Contractor may retain a

pervious qualified, independent testing laboratory. The laboratory must provide evidence of conforming to the requirements of ASTM E-329 "Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials used in Construction," and must have at least three (3) years of experience in working with pervious concrete. All test samples shall be identified by date and batch mix or truck load. Laboratory testing shall be done expeditiously, and results communicated to all concerned in a timely manner.

# 601.2. Field Testing:

Field testing shall be performed as per specification by either the General Contractor, his agent, or if specified by a <u>pervious concrete qualified</u>, test laboratory. To qualify, field agents shall have a minimum of (1) one year and 3 three projects experience in field testing pervious concrete.

Testing procedures are in a state of evolution at present. Samples, 2' x 2' can be cut from a typical slab, or made in on-site in forms. The sample, 2' x 2' by 6", the usual thickness of the pervious concrete will have a 2' x 2' x 12" form built around Caulk is then applied between the form and the pervious concrete. The added height provides a dam for the addition of water. The caulk prevents the water from seeping between the form and the edge of the pervious concrete. The form can be placed on a typical compacted base. Three inches of water can be placed inside the form after the concrete has cured partially, and the drainage time can be measured. The three inches of water should be accommodated below the upper surface of the pervious concrete at the same rate as the sub-base is capable of receiving the water. The three inches of water should pass through the pervious and the base in 3 minutes or less, if sub-base can accommodate that amount of water. SWFMD RESOURCE REGULATION TRAINING MEMORANDUM TM/ERP – 980521.a, Dated May 01, 1998, Page 2. "Site Drainage Conditions.)

#### 700. PAVEMENT TEST PROCEDURE:

# 701. Paving Material.

### 701.1 Responsibility.

The contractor shall be responsible for requiring a pervious concrete material supplier to provide a mix compliance statement on each shipping document. No deviation of the approved mix design will be accepted without the concurrence of the owner's engineer or agent.

#### 701.2 Paving Material.

At the owner's request, if batch certification is not adequate, a minimum frequency of one (1) test for each day of placement shall be conducted to verify the weight of material as delivered. As noted above rodded samples have no relevance to pervious concrete paving. The test shall be conducted in accordance with ASTM C-172 and C-29.

Mix shall be within  $\pm$  (5%) five percent of the design unit weight. If outside of range, mix proportions shall be modified to comply.

#### 702. Pavement Thickness Acceptance.

Prior to placement, Contractor shall confirm grade peg and/or form elevations to provide required thickness of the pervious slab. If an outside testing laboratory is employed, the following procedure shall be followed:

During placement a field engineer will verify form elevations and measure depth of placement at appropriate time intervals. Within 24 hours of placement core samples may also be taken in accordance with ASTMC-42. This must be done in the presence of a Charger Enterprises agent, and core cavities shall immediately be filled with pervious concrete. These cores shall be used for verification of

pavement thickness. At seven days from the placement of the slab, these core ends shall be trimmed to facilitate volume determination. Core unit weights shall be calculated based upon weight results when tested in accordance with ASTM-C-140 paragraph 14.1 (disregard suspended weight.)

Pavement acceptance shall be based on the average weight of the cores being within  $\pm$  (5%) five percent of the design unit weight. The thickness of the pavement shall be a minimum of five (5) inches for light traffic loadings. Additional thickness will be required for pavements subjected to frequent, heavy axle loadings.

As noted above, compressive strength tests can only be performed 28 days after concrete has been cured. Tests shall be performed in accordance with ASTM-C-39.

**703. Permeability.** One of the most important properties of pervious concrete is its percolation rate, which is directly related to its void content. A testing apparatus called a falling head Permeameter can be used to test a core sample to establish its coefficient of permeability

# NOTE:

This specification is provided on the basis of our many years of pervious concrete work experience. It reflects the state of the art of pervious concrete design and placement as seen through the eyes of a successful, pioneer, pervious contractor, Charger Enterprises, Inc. It is not intended to be applied to conditions unforeseen at the time of contractual agreement, and it may be altered with notice if significant changes in material sources, new equipment, or new techniques become available. Responsibility for its application and its wording is limited to contractual agreements between Charger Enterprises, Inc. and its customers and suppliers.